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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 C.F.R. § 1.53(b))

Attorney Docket No.	XDM 00-02
First Inventor or Application Identifier	Ping Liang
Title	UNIVERSAL SERIAL BUS FOR MOBILE DEVICES HAVING EXPANSION MODULES
Express Mail Label No.	EL404819366US

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: **Assistant Commissioner for Patents, Box Patent Application, Washington, DC 20231**

1. [X] * Fee Transmittal Form *(e.g., PTO/SB/17)* *(Submit an original and a duplicate for fee processing)*
2. [X] Specification [*Total Pages* 18]
   (preferred arrangement set forth below)
   - Descriptive title of the Invention
   - Cross References to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to Microfiche Appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
3. [X] Drawing(s) *(35 U.S.C. 113)* [*Total Sheets* 2]
4. Oath or Declaration [*Total Pages* 1]
   a. [X] Newly executed (original or copy)
   b. [ ] Copy from a prior application (37 C.F.R § 1.63(d)) *(for continuation/divisional with Box 16 completed)*
      i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 C.F.R. §§ 1.63(d)(2) and 1.33(b).

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5. [ ] Microfiche Computer Program *(Appendix)*
6. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   a. [ ] Computer Readable Copy
   b. [ ] Paper Copy (identical to computer copy)
   c. [ ] Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

7. [ ] Assignment Papers (cover sheet & document(s))
8. [ ] 37 C.F.R.§3.73(b) Statement *(when there is an assignee)* [ ] Power of Attorney
9. [ ] English Translation Document *(if applicable)*
10. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
11. [ ] Preliminary Amendment
12. [X] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
13. [X] * Small Entity Statement(s) *(PTO/SB/09-12)* [ ] Statement filed in prior application, Status still proper and desired
14. [ ] Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
15. [ ] Other: .....

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    Prior application information: Examiner _____ *Group / Art Unit:* _____
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City	Mission Viejo	*State*	CA	*Zip Code*	92692
Country	USA	*Telephone*	949-454-0898	*Fax*	949-454-0898

Name (Print/Type)	Hugh P. Gortler	*Registration No. (Attorney/Agent)*	33,890
Signature		*Date*	9/21/00

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See 37 C.F.R. §§ 1.27 and 1.28.

TOTAL AMOUNT OF PAYMENT ($) $510.00

Complete if Known	
Application Number	
Filing Date	
First Named Inventor	Ping Liang
Examiner Name	
Group / Art Unit	
Attorney Docket No.	XDM 00-002

METHOD OF PAYMENT (check one)

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FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
101	690	201	345	Utility filing fee	$345.00
106	310	206	155	Design filing fee	
107	480	207	240	Plant filing fee	
108	690	208	345	Reissue filing fee	
114	150	214	75	Provisional filing fee	

SUBTOTAL (1) ($) $345.00

2. EXTRA CLAIM FEES

		Extra Claims		Fee from below	Fee Paid
Total Claims	34	-20** = 14	X	$9	= $126
Independent Claims	4	- 3** = 1	X	$39	= $39
Multiple Dependent					=

**or number previously paid, if greater; For Reissues, see below

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
103	18	203	9	Claims in excess of 20
102	78	202	39	Independent claims in excess of 3
104	260	204	130	Multiple dependent claim, if not paid
109	78	209	39	** Reissue independent claims over original patent
110	18	210	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($) $165

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet.	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for reply within first month	
116	380	216	190	Extension for reply within second month	
117	870	217	435	Extension for reply within third month	
118	1,360	218	680	Extension for reply within fourth month	
128	1,850	228	925	Extension for reply within fifth month	
119	300	219	150	Notice of Appeal	
120	300	220	150	Filing a brief in support of an appeal	
121	260	221	130	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive - unavoidable	
141	1,210	241	605	Petition to revive - unintentional	
142	1,210	242	605	Utility issue fee (or reissue)	
143	430	243	215	Design issue fee	
144	580	244	290	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Petitions related to provisional applications	
126	240	126	240	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	
146	690	246	345	Filing a submission after final rejection (37 CFR § 1.129(a))	
149	690	249	345	For each additional invention to be examined (37 CFR § 1.129(b))	

Other fee (specify) _____

Other fee (specify) _____

* Reduced by Basic Filing Fee Paid

SUBTOTAL (3) ($) $0

SUBMITTED BY				Complete (if applicable)	
Name (Print/Type)	Hugh P. Gortler	Registration No. (Attorney/Agent)	33,890	Telephone	949-454-0898
Signature				Date	9/21/00

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STATEMENT CLAIMING SMALL ENTITY STATUS (37 CFR 1.9(f) & 1.27(c))--SMALL BUSINESS CONCERN	Docket Number (Optional) XDM 00-02

Applicant, Patentee, or Identifier: Ping Liang
Application or Patent No.:
Filed or Issued:
Title: UNIVERSAL SERIAL BUS FOR MOBILE DEVICES HAVING EXPANSION MODULES

I hereby state that I am
- ☐ the owner of the small business concern identified below:
- ☒ an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF SMALL BUSINESS CONCERN TRANSDIMENSION INC.

ADDRESS OF SMALL BUSINESS CONCERN 2 Venture, Suite 500, Irvine, California 92618

I hereby state that the above identified small business concern qualifies as a small business concern as defined in 13 CFR Part 121 for purposes of paying reduced fees to the United States Patent and Trademark Office. Questions related to size standards for a small business concern may be directed to. Small Business Administration, Size Standards Staff, 409 Third Street, SW, Washington, DC 20416.

I hereby state that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention described in:

- ☒ the specification filed herewith with title as listed above.
- ☐ the application identified above.
- ☐ the patent identified above.

If the rights held by the above identified small business concern are not exclusive, each individual, concern, or organization having rights in the invention must file separate statements as to their status as small entities, and no rights to the invention are held by any person, other than the inventor, who would not qualify as an independent inventor under 37 CFR 1.9(c) if that person made the invention, or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d), or a nonprofit organization under 37 CFR 1.9(e).

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NAME OF PERSON SIGNING Ping Liang

TITLE OF PERSON IF OTHER THAN OWNER President

ADDRESS OF PERSON SIGNING 18 Vienne, Irvine, California 92606

SIGNATURE _____ DATE 9/20/00

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PATENT
XDM 00-02

UNIVERSAL SERIAL BUS FOR MOBILE DEVICES HAVING EXPANSION MODULES

By

Ping Liang

UNIVERSAL SERIAL BUS FOR MOBILE DEVICES HAVING EXPANSION MODULES

BACKGROUND

The present invention relates generally to data communication. More particularly, the present invention relates to a Universal Serial Bus ("USB") interface for mobile devices.

Expansion modules can increase functionality of certain mobile devices. For instance, an expansion module can be plugged into a personal digital assistant ("PDA") to provide network connectivity or wireless communications. The expansion module might include a game card.

A typical expansion module is connected to a mobile device via a parallel bus. The bus is proprietary to each device, and it typically has between twenty-four and sixty-four pins. Because the bus is proprietary, the expansion module cannot be readily used with personal computers, PDAs made by different manufacturers, and other computer-based products.

SUMMARY

According to one aspect of the present invention, a mobile device includes a housing having an expansion module bay; and an expansion module having a first USB connector. A second USB connector is positioned inside the bay to mate with the first USB connector when the expansion module is inserted in the bay.

Other aspects and advantages of the present invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an illustration of a PDA including an expansion module;

Figure 2 is an illustration of first and second USB connectors for the PDA and the expansion module of Figure 1;

Figure 3 is an illustration of various components of the PDA and the expansion module;

Figure 4 is an illustration of the expansion module and a USB adapter for interfacing the expansion module with another USB host or device;

Figure 5 is an illustration of the PDA and a USB adapter for interfacing the PDA with another PDA, USB host or USB device; and

Figure 6 is an illustration of a power conversion circuit.

DETAILED DESCRPTION

The present invention will be described in connection with a mobile device commonly known as a personal digital assistant, pocket computer or palmtop PC. This device will be referred to as a PDA throughout the application. It is understood, however, that the present invention is not limited to PDAs and may be embodied in other types of mobile devices, such as cellular phones and digital cameras.

Reference is made to Figure 1, which shows a PDA 10. The PDA 10 includes a housing 12 and other standard components including, but not limited to, a processor, memory, a display, I/O ports and a battery. These other standard components are not shown in Figure 1.

The housing 12 has an expansion module bay 14 for receiving an expansion module 16. The expansion module 16 can be plugged into the mobile device 10 to provide enhanced functionality to the mobile device 10 (e.g., network connectivity, wireless communication, a game card).

The expansion module 16 has a first USB connector 18 (also referred to as the module USB connector 18). A second USB connector

20 (also referred to as the PDA USB connector 20) is positioned inside the expansion module bay 14 to mate with the module USB connector 18 when the expansion module 16 is inserted in the bay 14. The module and PDA USB connectors 18 and 20 have a form factor that is different than a standard USB form factor. Considering the small size of most PDAs, the module and PDA USB connectors 18 and 20 will probably have a form factor that is smaller than a standard USB form factor.

Reference is now made to Figure 2. Each USB connector 18 and 20 includes a power pin (Vbus), a ground pin (GND), a data-plus pin (D+) and a data-minus pin (D-). Each USB connector 18 and 20 may also include an identification (ID) pin. The identification pin indicates a USB host or a USB device. The identification pin (ID) is grounded for a host and it is floating for a device. In Figure 2, the module USB connector 18 is shown as having a male configuration and the PDA USB connector 20 is shown as having a female configuration. However, the PDA 10 may have a male USB connector and the expansion module 16 may have a female USB connector.

Reference is now made to Figure 3, which shows the expansion module 16 in greater detail. The expansion module 16 includes one or more circuits 52 for providing an expansion module function (e.g., a game card, a modem) and a USB interface 54 connected between the module USB connector 18 and the circuits 52 providing the expansion module function. The expansion module 16 may be configured as a USB device. According to the USB Specification, Revision 2.0, a USB device includes three layers: a bus interface that transmits and receives packets, a second layer that handles routing data between the bus interface and various endpoints on the USB device, and a third layer that provides device functionality. For the purposes of this application, the USB interface 54 includes both the bus interface and the second layer. The USB interface

54 may be implemented through any combination of hardware, firmware and software.

The expansion module 16 also includes a module power conversion circuit 56 coupled between the module USB connector 18 and the USB interface 54. The module conversion circuit 56 reduces the voltage of a signal on the module USB connector 18 to a corresponding interface voltage and provides the reduced voltage to the USB interface 54 if the voltage on the module USB connector 18 is higher than the corresponding interface voltage. The module conversion circuit 56 boosts the voltage of a signal on the module USB connector 18 to a corresponding interface voltage and provides the boosted voltage to the USB interface 54 if the voltage on the module USB connector 18 is less than the corresponding interface voltage. The module conversion circuit 56 passes through a signal (that is, doesn't change the signal voltage) if the signal on the module USB connector 18 is at the same voltage as the corresponding interface voltage. The signal may be a data signal (D+ or (D-) and/or the power signal (Vbus).

Consider the following two examples. In the first example, the PDA 10 provides a power signal at 3 volts and data signals at +1.8 volts and -1.8 volts; and the USB interface 54 of the expansion module 16 also operates with a power signal at 3 volts and data signals at +1.8 and -1.8 volts. In this first example, the module conversion circuit 56 receives the power and data signals from the module USB connector 18 and passes through the power and data signals to the USB interface 54. If both the PDA 10 and the expansion module 16 operate at the same USB voltages, the module conversion circuit 56 may be omitted.

In the second example, the PDA 10 provides a power signal at 5 volts and data signals at +3.3 volts and -3.3 volts, but the USB interface 54 of the expansion module 16 operates with a power signal at 2.7 volts and data signals at +1.8 and -1.8 volts. In this second example, the module

conversion circuit 56 receives the power signal from the power pin (Vbus) of the module USB connector 18, reduces the voltage to 2.7 volts and supplies the reduced voltage power signal to the module USB interface 54. When the PDA 10 sends data to the expansion module 16, the module conversion circuit 56 receives the data signals from the data pins (D+ and D-) of the module USB connector 18, reduces the voltages from +3.3 volts and -3.3 volts to +1.8 volts and -1.8 volts, and supplies the reduced voltage data signals to the module USB interface 54. When the expansion module 16 sends data to the PDA 10, the module conversion circuit 56 receives the +1.8 and -1.8 voltage data signals from the module USB interface 54, boosts the data signals to +3.3 volts and -3.3 volts, and sends the boosted voltage data signals to the data pins (D+ and D-) of the module USB connector 18.

Reference is now made to Figure 4, which shows a USB host or device 100 that operates at standard USB voltages. Figure 4 also shows an adapter 102 for allowing the expansion module 16 to communicate with the USB host or device 100. The adapter 102 includes a cable 104, a first USB connector 106 at one end of the cable 104, and a second USB connector 108 at the other end of the cable 104. The first connector 106 can mate with the module USB connector 18 and the second connector 108 can mate with a standard USB connector on the USB host or device 100. The adapter 102 may be used to connect the expansion module 16 to the USB host or device 100. This allows the USB host or device 100 to use the functionality of the expansion module. For example, the expansion module 16 may include a game card and the USB host 100 may be a personal computer.

Consider an example in which a personal computer 100 provides a power signal at 5 volts and data signals at +3.3 volts and -3.3 volts, but the USB interface 54 of the expansion module 16 operates with a power signal at 2.7 volts and data signals at +1.8 and -1.8 volts. In this example, the

module conversion circuit 56 receives the power signal from the power pin (Vbus) of the module USB connector 18, reduces the voltage to 2.7 volts and supplies the reduced voltage power signal to the module USB interface 54. When the personal computer 100 sends data to the expansion module 16, the module conversion circuit 56 receives the data signals from the data pins (D+ and D-) of the module USB connector 18, reduces the voltages from +3.3 volts and -3.3 volts to +1.8 volts and -1.8 volts, and supplies the reduced voltage data signals to the module USB interface 54. When the expansion module 16 sends data to the personal computer 100, the module conversion circuit 56 receives the +1.8 and -1.8 voltage data signals from the module USB interface 54, boosts the data signals to +3.3 volts and -3.3 volts, and sends the boosted voltage data signals to the data pins (D+ and D-) of the module USB connector 18.

Thus, the single USB connector 18 on the expansion module 16 serves two purposes. The single USB connector 18 can be used to interface the expansion module 16 with the PDA 10, and it can be used to connect the expansion module 16 to other USB hosts and devices.

The first and second connectors 106 and 108 may be connected by means other than a cable. For example, the first and second connectors 106 and 108 may be connected directly together without a cable or other means.

Returning now to Figure 3, the PDA 10 includes a processor 72 and the memory 74. The memory 74 of the PDA 10 is encoded with an operating system and different applications (e.g., personal information manager, wireless Internet messaging, e-mail). Among other things, the operating system instructs the processor 72 to function as a USB controller (also referenced by numeral 72). The USB controller 72 may be configured as a USB host or a USB device.

In general, the USB host provides an interface to USB devices. For example, the USB host is responsible for detecting the attachment and

removal of USB devices, managing the control flow between the host and the USB devices, managing the data flow between the host and the USB devices, collecting status and activity statistics, and providing power to attached USB devices. The USB host includes three layers: a USB bus interface, a USB system and a client. The USB host may be implemented through any combination of hardware, firmware and software. A root hub or a simplified root hub is integrated within the USB host controller to provide attachment points for one or more USB-compliant devices.

The PDA 10 may also have a power conversion circuit 76 coupled between the USB controller 72 and the PDA USB connector 20. If the voltage of a signal on the PDA USB connector 20 is higher than a corresponding signal voltage for the USB controller 72, the PDA conversion circuit 76 reduces the voltage of the signal on the PDA USB connector 20 to the corresponding controller signal voltage and provides the reduced voltage signal to the USB controller 72. If the voltage of a signal on the PDA USB connector 20 is less than the corresponding controller signal voltage, the PDA conversion circuit 76 boosts the voltage of the signal on the PDA USB connector 20 to the corresponding controller signal voltage and provides the boosted voltage signal to the USB controller 72. If the voltage of a signal from the USB controller 72 is greater than the voltage expected at the PDA USB connector 20, the PDA conversion circuit 76 reduces the controller signal voltage to the expected voltage and provides the reduced voltage signal to the PDA USB connector 20. If the controller signal voltage is less than the voltage expected at the PDA USB connector 20, the PDA conversion circuit 76 boosts the voltage of the controller signal to the expected voltage and provides the boosted voltage signal to the PDA USB connector 20. The PDA conversion circuit 76 passes through a signal if the signal on the PDA USB connector 20 is at the same voltage as the corresponding USB controller voltage. The signal may be a data signal (D+ or (D-) and/or the

power signal (Vbus). If both the PDA 10 and the expansion module 16 operate at the same USB voltages, the PDA conversion circuit 76 may be omitted.

Both the PDA 10 and the expansion module 16 may have conversion circuits 76 and 56. However, only one of the conversion circuits 76 or 56 performs the power conversion at any time. The side that performs the power conversion (either the PDA 10 or the expansion module 16) can be specified by convention. Therefore, only the side 10 or 16 that performs the power conversion may be provided with the power conversion circuit 76 or 56.

Reference is now made to Figure 5, which shows an adapter 202 for allowing the PDA 10 to communicate with another PDA, USB host or USB device 210. The adapter 202 includes a cable 204, a first USB connector 206 at one end of the cable 204, and a second USB connector 208 at the other end of the cable 104. The first connector 206 can mate with the PDA USB connector 20 and the second connector 208 can mate with a standard USB connector on the PDA, USB host or USB device 210. When connected to a USB device, the PDA functions as a USB host. When connected to a USB host, the PDA 16 functions as a USB device.

For example, the PDA 10 is connected to a personal computer to synchronize with the personal computer. The PDA 10 operates as a USB device at voltages of 2.7 volts for power and +1.8 and -1.8 volts for data, and the computer operates at standard USB voltages of 5 volts for power and +3.3 volts and -3.3 volts for data. Since the computer includes a USB host, it provides USB power to the PDA 10. The PDA conversion circuit 76 receives the power signal from the power pin (Vbus) of the PDA USB connector 20, reduces the voltage to 2.7 volts and supplies the reduced voltage power signal to the USB controller 72. When the PDA 10 receives data from the computer, the PDA conversion circuit 76 receives the data signals from the data pins (D+ and D-) of the PDA USB connector 20,

reduces the voltages from +3.3 volts and -3.3 volts to +1.8 volts and -1.8 volts, and supplies the reduced voltage data signals to the USB controller 72. When the PDA 10 sends data to the computer, the PDA conversion circuit 76 receives the +1.8 and -1.8 voltage data signals from the USB controller 72, boosts the voltages to +3.3 volts and -3.3 volts, and sends the boosted voltage data signals to the data pins (D+ and D-) of the PDA USB connector 20.

In the alternative, the second connector 208 can mate with a PDA USB connector on another PDA 210. Resulting is a peer-to-peer connection between the two PDAs 10 and 210. In this arrangement, one PDA would function as the USB host and the other PDA would function as a USB device.

Thus, the single USB connector 20 on the PDA 10 serves two purposes. The single USB connector 20 can be used to interface the expansion module 16 with the PDA 10, and it can be used to connect the PDA 10 to other USB hosts and devices.

Reference is now made to Figure 6, which shows a power conversion circuit 310 that may be used as either the expansion module power conversion circuit 56 or the PDA power conversion circuit 76. The power conversion circuit 310 includes a voltage sensor 312 for sensing the voltage on the USB connector 18 or 20. Sensed voltage is supplied to a controller 314. The controller 314 determines whether the voltage of the signal should be boosted, reduced or passed through. If a signal voltage should be boosted, the controller 314 commands a first switch 316 to send the signal to a circuit such as a charge pump 318. An output of the charge pump 318 provides the boosted voltage signal to a second switch 320. If a signal voltage should be reduced, the controller 314 commands the first switch 316 to send the signal to a circuit such as a voltage regulator 322. An output of the voltage regulator 322 provides the reduced voltage signal to the second switch 320. If a signal should be passed through, the

controller 314 commands the first switch 316 to send the signal directly to the second switch 320.

The controller 314 can configure the voltage regulator 322 and the charge pump 318 to provide the proper levels of voltage reduction or voltage boost. The controller 314 also commands the second switch 320 to provide the signals onto an internal bus 324. The internal bus 324 may be connected to the USB controller 72 or the USB interface 54.

For signals flowing from the internal bus 324, the controller 314 commands the second switch 320 to send the signals along the correct paths (e.g., directly to the first switch 316, to the voltage regulator 322, to the charge pump 318). The controller 314 also commands the first switch 316 to supply the proper signals to the conductors of the USB connector 18 or 20.

The power conversion circuit 310 can determine whether to boost or reduce the voltage in a variety of ways. For example, if the USB controller 72 is configured as a USB device, the power conversion circuit 310 for the PDA 10 may look at the voltages on the power (Vbus) or data (D+ and D-) pins to determine whether voltage should be boosted or reduced. If the USB controller 72 is configured as a USB host, the power conversion circuit 310 for the PDA 16 may look at the voltages on the data (D+ and D-) pins or it may examine configuration and device descriptors to determine whether voltage should be boosted or reduced.

Thus disclosed is a PDA including an expansion module that can be used with PDAs and other devices having USB interfaces. Thus, a PDA according to the present invention can utilize a wide range of expansion modules (even those operating at different voltages), and an expansion module according to the present invention can be used with a wide range of USB hosts and devices. Moreover, the single USB connector of the mobile device can interface with an expansion module or it can connect to other USB hosts and devices. Similarly, the single USB connector of the

expansion module can interface with a mobile device or it can connect to other USB hosts and devices. Thus, a single USB connector on the mobile device serves two purposes, and a single USB port on the expansion module serves two purposes.

Although the present invention was described in connection with a PDA, it is not so limited. The present invention may be applied to notebook computers, "Smart Appliances," cell phones and any other types of mobile devices.

The present invention is not limited to the specific embodiments described and illustrated above. Instead, the present invention is construed according to the claims that follow.

WHAT IS CLAIMED IS:

1. A mobile device comprising:
a housing having an expansion module bay;
an expansion module having a first USB connector; and
a second USB connector positioned inside the bay to mate with the first USB connector when the expansion module is inserted in the bay.

2. The device of claim 1, wherein the first and second connectors have a form factor that is different than a standard USB form factor.

3. The device of claim 1, wherein the first and second connectors have a form factor that is smaller than a standard USB form factor.

4. The device of claim 1, further comprising a USB controller inside the housing of the mobile device.

5. The device of claim 4, wherein the USB controller is configured to function as a USB host.

6. The device of claim 4, wherein the USB controller is configured to function as a USB device.

7. The device of claim 1, wherein the expansion module further includes a USB interface and a conversion circuit coupled between the USB interface and the second USB connector.

8. The device of claim 7, wherein the conversion circuit reduces the voltage of a signal on the second USB connector to a corresponding interface voltage and provides the reduced voltage to the interface if the

voltage on the second USB connector is higher than the corresponding interface voltage.

9. The device of claim 7, wherein the conversion circuit boosts the voltage of a signal on the second USB connector to a corresponding interface voltage and provides the boosted voltage to the interface if the voltage on the second USB connector is less than the corresponding interface voltage.

10. The device of claim 7, wherein the conversion circuit reduces the voltage of an interface signal to a voltage expected at the second connector and provides the reduced voltage to the second connector if the interface voltage is greater than expected.

11. The device of claim 7, wherein the conversion circuit boosts the voltage of an interface signal to a voltage expected at the second connector and provides the boosted voltage to the second connector if the interface voltage is less than expected.

12. The device of claim 1, further comprising a USB controller and a conversion circuit within the housing, the conversion circuit coupled between the USB controller and the first USB connector.

13. The device of claim 12, wherein the conversion circuit reduces the voltage of a signal on the first USB connector to a corresponding controller voltage and provides the reduced voltage to the controller if the voltage on the first USB connector is higher than the corresponding controller voltage.

14. The device of claim 12, wherein the conversion circuit boosts the voltage of a signal on the first USB connector to a corresponding controller voltage and provides the boosted voltage to the controller if the voltage on the first USB connector is less than the corresponding controller voltage.

15. The device of claim 12, wherein the conversion circuit reduces the voltage of a controller signal to a voltage expected at the first connector and provides the reduced voltage to the first connector if the controller voltage is greater than the corresponding voltage expected at the first connector.

16. The device of claim 12, wherein the conversion circuit boosts the voltage of a controller signal to a voltage expected at the first connector and provides the boosted voltage to the first connector if the controller voltage is less than the corresponding voltage expected at the first connector.

17. The device of claim 1, further comprising an adapter having a third connector that is connected to a fourth connector, the third connector being a USB connector having a standard USB form factor, the fourth connector configured to mate with one of the first and second connectors.

18. A mobile device comprising:

a housing having an expansion module bay;

a USB controller within the housing; and

a USB connector coupled to the USB controller, the USB connector positioned within the expansion bay module in an expansion module-receiving position.

19. The device of claim 18, wherein the USB connector has a non-standard USB form factor.

20. The device of claim 18, further comprising a conversion circuit within the housing and coupled between the USB controller and the USB connector.

21. The device of claim 20, wherein the conversion circuit reduces the voltage of a signal on the USB connector to a corresponding controller voltage and provides the reduced voltage to the controller if the voltage on the USB connector is higher than the corresponding controller voltage.

22. The device of claim 20, wherein the conversion circuit boosts the voltage of a signal on the USB connector to a corresponding controller voltage and provides the boosted voltage to the controller if the voltage on the USB connector is less than the corresponding controller voltage.

23. The device of claim 20, wherein the conversion circuit reduces the voltage of a controller signal to a voltage expected at the USB connector and provides the reduced voltage to the USB connector if the controller voltage is greater than the corresponding voltage expected at the USB connector.

24. The device of claim 20, wherein the conversion circuit boosts the voltage of a controller signal to a voltage expected at the USB connector and provides the boosted voltage to the USB connector if the controller voltage is less than the corresponding voltage expected at the USB connector.

25. The device of claim 18, wherein the USB controller is a USB host.

26. The device of claim 18, wherein the USB controller is a USB device.

27. A personal digital assistant comprising:

a housing having an expansion module bay;

a USB controller within the housing; and

a USB connector for the USB controller, the USB connector being positioned within the expansion module bay, the USB connector being positioned to receive a mating USB connector of an expansion module.

28. An expansion module for a mobile device, the expansion module comprising:

a USB interface; and

a USB connector for the USB interface.

29. The device of claim 28, wherein the USB connector has a non-standard USB form factor.

30. The device of claim 28, further comprising a conversion circuit coupled between the USB interface and the USB connector.

31. The device of claim 30, wherein the conversion circuit reduces the voltage of a signal on the USB connector to a corresponding interface voltage and provides the reduced voltage to the interface if the voltage on the USB connector is higher than the corresponding expansion module voltage.

32. The device of claim 30, wherein the conversion circuit boosts the voltage of a signal on the USB connector to a corresponding interface voltage and provides the boosted voltage to the interface if the voltage on the USB connector is less than the corresponding expansion module voltage.

33. The device of claim 30, wherein the conversion circuit reduces the voltage of an interface signal to a voltage expected at the USB connector and provides the reduced voltage to the USB connector if the interface voltage is greater than the corresponding voltage expected at the USB connector.

34. The device of claim 30, wherein the conversion circuit boosts the voltage of an interface signal to a voltage expected at the USB connector and provides the boosted voltage to the USB connector if the interface voltage is less than the corresponding voltage expected at the USB connector.

UNIVERSAL SERIAL BUS FOR MOBILE DEVICES HAVING EXPANSION MODULES

ABSTRACT OF THE DISCLOSURE

A mobile device such as a personal digital assistant ("PDA") includes a Universal Serial Bus ("USB") connector in an expansion module bay. An expansion module for the mobile device includes a USB connector that mates with the connector in the expansion module bay. The expansion module may be plugged directly into the expansion bay of the mobile device, or it may be connected (via an adapter) to another device having a standard USB downstream connector.

FIG. 1

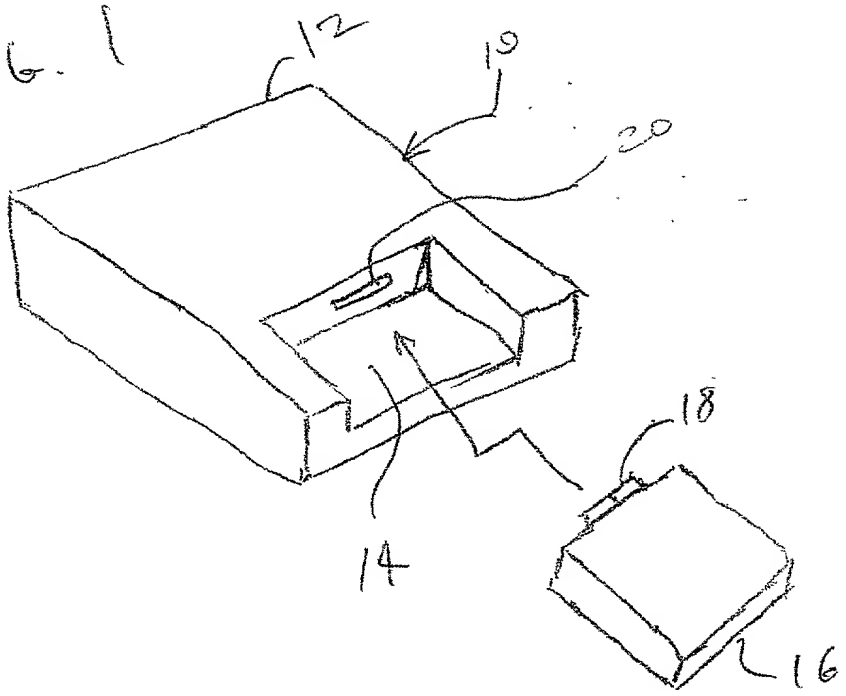


FIG. 2

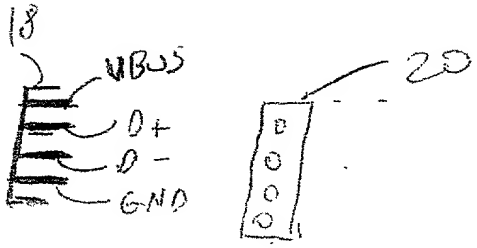


FIG. 4

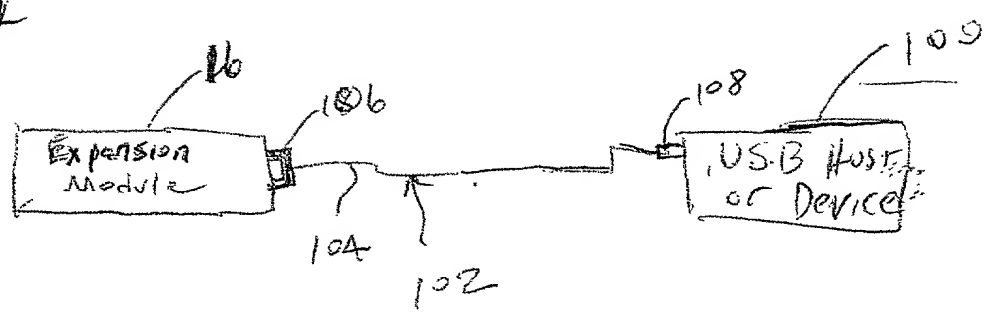
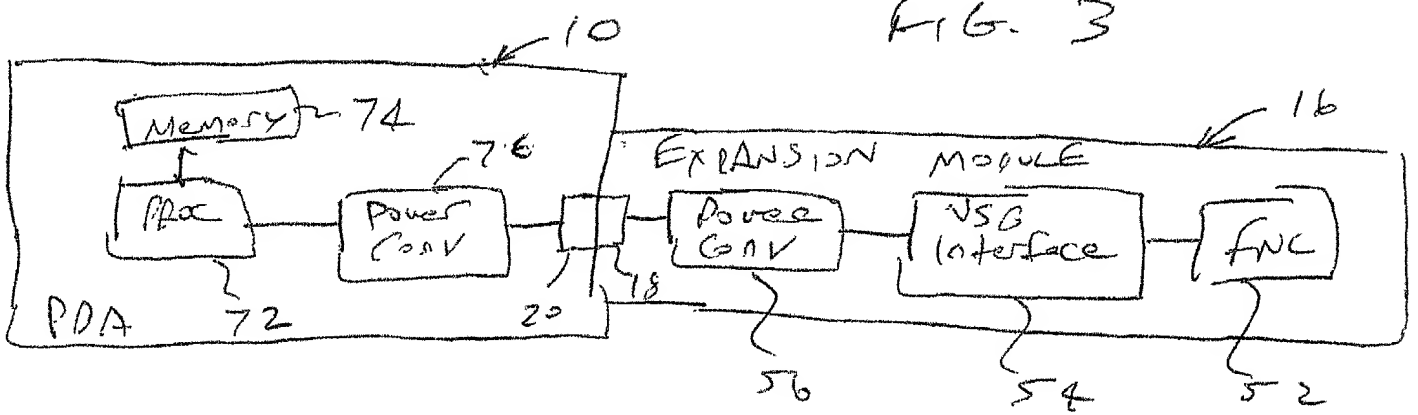


FIG. 3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Proc
Power Conv
EXPANSION MODULE
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Power Conv
USB Interface
FNC
PDA
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18
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54
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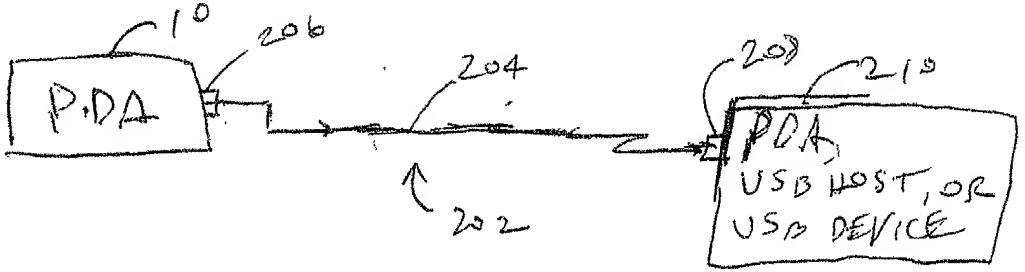
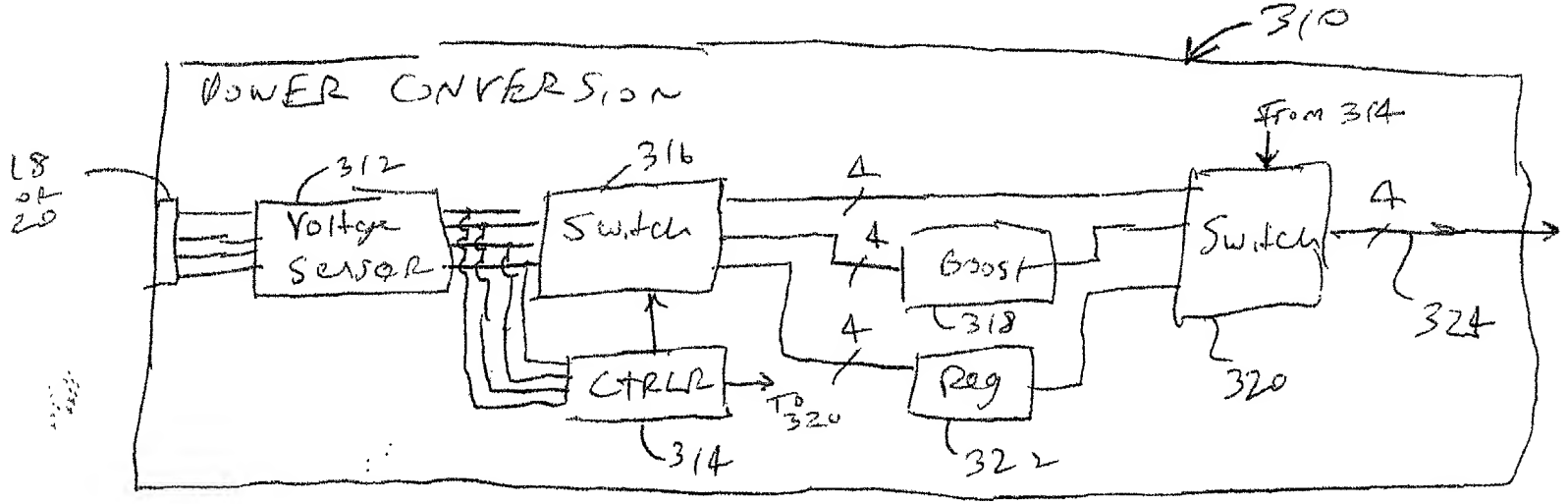

10
206
204
208
210
PDA
PDA
USB HOST, OR
USB DEVICE
202

FIG. 5


310
POWER CONVERSION
From 314
L8 or 20
312
Voltage Sensor
316
Switch
4
4
Boost
318
Switch
4
324
4
CTRLR
To 320
Reg
320
314
322

Docket No. XDM 00-02

DECLARATION, PETITION & POWER OF ATTORNEY

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled UNIVERSAL SERIAL BUS FOR MOBILE DEVICES HAVING EXPANSION MODULES, the specification of which is attached hereto.

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

And I hereby appoint H. P. GORTLER, Reg. 33,890, LAW OFFICE OF HUGH P. GORTLER, 23 Arrivo Drive, Mission Viejo, CA 92692, (949) 454-0898, as my attorney with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith and before competent International authorities.

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(949) 454-0898

Wherefore I pray that Letters Patent be granted to me for the invention or discovery described and claimed in the foregoing specification and claims, and I hereby subscribe my name to the foregoing specification and claims, declaration, power of attorney, and this petition.

Full name of sole inventor Ping Liang

Inventor's signature [signature] Date: 9/20/00

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